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ABSTRACT

This policy analysis report on the Dade County Public Schools was written as part of an Honors Student Mentor Group sponsored by the Institute for Public Policy and Citizenship Studies. The students visited several schools, conducting personal interviews with staff and students, and reviewed statistical sources on a weekly basis under the guidance of an associate professor of history, who was also the director of the Dade Community Summit Conference on Building Effective Schools. Fourteen recommendations were cited as follows: (1) hands-on mathematics projects should be promoted at every stage of schooling; (2) manipulatives should be used extensively; (3) use of workbooks and ditto sheets should be minimized; (4) each student should own a calculator and have it available for daily use; (5) computers should be used primarily for higher order cognitive activities, rather than basic skills drill; (6) portfolio assessment should be encouraged for the annual evaluation of students, teachers, and schools; (7) all elementary schools should have specialists in mathematics, science, and computer sciences; (8) cross-grouping should be used widely; (9) each school should have a mathematics coordinator for resources, inservice programs, curriculum design, and peer coaching; (10) all elementary mathematics instructors should update their own mathematics training; (11) Florida state certification requirements for elementary school teachers should be strengthened in terms of mathematics coursework; (12) specific linguistic difficulties of minorities should be assimilated into corrective teaching practices; (13) mathematics instruction should stress multicultural traditions; and (14) college student volunteers should be recruited as tutors. (JJK)

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MATHEMATICS INSTRUCTION IN DADE'S ELEMENTARY SCHOOLS:

IMPROVING CURRICULUM, TEACHING METHODS AND STAFFING.

AN HONORS STUDENT MENTOR GROUP PROJECT
INSTITUTE FOR PUBLIC POLICY AND CITIZENSHIP STUDIES
FLORIDA INTERNATIONAL UNIVERSITY

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RECOMMENDATIONS.

RECOMMENDATION 1: Hands-on math projects should be undertaken at every stage of instruction. Such activities include the use of manipulatives, games, and other means of making math real and personal to students. Even though such activities are called for in the District's Total Mathematics Program (TMP) and in most of the other math systems in use in the DCPS, they are not actually carried out by many of the teachers in the schools. Closer monitoring of math instruction by principals and peers is needed to assure that hands-on activities which maximize comprehension are being used. TADS observations should be made during elementary math classes—as is seldom done today.

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RECOMMENDATION 2: Manipulatives should be used widely. All elementary teachers with responsibilities for math instruction should be trained in the use of appropriate manipulatives and have access to them in the classroom. The use of manipulatives should be given special emphasis in schools with a preponderance of low-income students.

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RECOMMENDATION 3: The use of workbooks and ditto sheets should be minimized. Students should not be spending large amounts of time in unsupervised, individual seatwork. Any use of workbooks and dittos should be under the active supervision of the teacher. Every page of workbook and ditto work should be marked right away by the teacher so that the student does not perpetuate errors. Preference should be given to more active and interesting methods of instruction than workbooks and dittoes.

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RECOMMENDATION 4: Each student should own a calculator and have it available in math class daily. Business partners should be asked to pay for the calculators.

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RECOMMENDATION 5: Computers should be used primarily for higher order cognitive activities, rather than basic skills drill. Even very young elementary students have the ability to engage in more creative, interactive work with computers. Computer programs in the LOGO and BASIC languages lend themselves readily to interactive work by elementary students. Through such programs, students can deal conceptually with mathematics in many new ways. They can also do computer graphics and word processing.

RECOMMENDATION 6: Writing of each student should be collected each year in two portfolios which would be used in evaluating the student, the teacher and the school. The first portfolio would deal with literature and social science and the second with math and science. Math writing would include discussions of hands-on activities and word problems. Students would also discuss problems in which they got answers wrong. Precision of language in dealing with math concepts should be emphasized in evaluating these writings. By the requirement of writing portfolios for each student, each teacher and school will thereby be guided toward teaching math at least partially through writing.

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RECOMMENDATION 7: Specialists in math, science and computers should be hired for elementary schools. Existing teachers should be encouraged to take further courses in math, science, and computers in order to qualify as specialists.

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RECOMMENDATION 8: Cross-grouping should be used widely. This means that two teachers in nearby classrooms should divide their responsibilities so that one teaches math and science and the other teaches language and social studies to each of two classes. In this manner, students will be taught by specialist teachers who enjoy and understand math.

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RECOMMENDATION 9: Each school should have a Math Resource Teacher who would teach courses, provide inservice education, plan curriculum, coach peers, and coordinate the school math program.

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RECOMMENDATION 10: Every elementary teacher with responsibility for math instruction should take sixty hours of in-service training over the next five years which stresses the use of hands-on approaches to teaching math.

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RECOMMENDATION 11: The DCPS should pursue the strengthening of state certification requirements for elementary teachers so that they include more math courses. State recertification requirements should also be made more focused and cohesive in terms of the program of courses taken.

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RECOMMENDATION 12: The growing research literature on linguistic problems of minorities in understanding math terms and concepts should be assimilated into the teaching practices of DCPS elementary math teachers.

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RECOMMENDATION 13: Math instruction in Dade County should be multicultural. Students should be taught that their own culture has an important mathematically-oriented tradition. And they should be taught to understand and respect the mathematically-oriented traditions of other cultures, particularly those heavily represented in Dade County.

RECOMMENDATION 14: *College student volunteers should be recruited to help tutor low-income, minority students. Special efforts should be made to recruit students with majors in math, computer science, natural science and engineering.*

INTRODUCTION.

America as a nation is falling behind in math and science education. Our students perform poorly on math and science tests, relative to students in other industrialized nations. [Lindquist; Dossey; McKnight.] The problems are most severe with older students, but have their roots in elementary education.

Too many students leave school unable to perform math at a satisfactory level either at work or in college. Over 75% of the jobs in America today require knowledge of simple algebra and geometry. [NRC, p. 2.] The Florida Chamber of Commerce sees the improvement of math/science/computer education as essential if Florida is to develop an important high technology industrial sector. Locally, employers complain of the innumeracy of recent graduates from the DCPS. Many high technology firms have left Miami in recent years, and complaints about the quality of the educational system were often central to their leaving.

Both in Miami and around the nation, employers, colleges and the military are burdened by the need to provide remedial education. They have to do over at great cost what should have been done right the first time in the public schools.

Of math courses being taught in American colleges today, 60% are really courses which should have been taught in the high schools. [NRC, p. 13.] Locally, around two-thirds of the students entering Miami-Dade Community College require remedial, pre-college courses in math. And 68% of MDCC students fail the math section of the College Level Academic Skills Test (CLAST) when they take the test for the first time after having had two years of college instruction. [FDOE.] This test is normed at the national twelfth grade level. The community college cannot get most of its students up to the high school level even after two years of work, thus indicating the very low level at which the students left high school.

Complicating the task of the schools in math instruction is the quantitative revolution of the past thirty years. With the increasing use of computers, math and statistics have become more and more central to the functioning of modern society. Americans are deluged with mathematical information at work, reading newspapers, making health care decisions, and considering personal financial options. People today need to know how to evaluate mathematical and statistical alternatives. And they need to know how to use computers and calculators to apply math and statistics to the problems which they encounter. Math is no longer simply about plugging in equations to generate answers. A person who possesses the kind of mathematical power required of ordinary people today has a sophisticated repertoire of skills and understanding and can evaluate the strengths and weaknesses of the quantitative information being presented, as well as carry out mathematical analysis of a simple sort.

According to the National Research Council, there are six important modes of mathematical thinking which are useful to everyone:

> **1. MODELING—Representing worldly phenomena by mental constructs, often visual or symbolic, that capture important and useful features.**
>
> **2. OPTIMIZATION—Finding the best solution (least expensive or most efficient) by asking "what if" and exploring all possibilities.**
>
> **3. SYMBOLISM—Extending natural language to symbolic representation of abstract concepts in an economical form that makes possible both communication and computation.**
>
> **4. INFERENCE—Reasoning from data, from premises, from graphs, from incomplete and inconsistent sources.**
>
> **5. LOGICAL ANALYSIS—Seeking implications of premises and searching for first principles to explain observed phenomena.**
>
> **6. ABSTRACTION—Singling out for special study certain properties common to many different phenomenon.**
> [NRC, p. 31.]

In order to enable today's students to master these essential mathematical modes of thought, the way math is taught has to change. The passive "drill and skill" approach no longer is adequate. Students cannot gain sufficient insight by simply listening and imitating. Computation and rules—the elements of math which are emphasized today—are not the most important aspects. Math is more than simply the harsh imperatives of accuracy, speed and memory. Math is also softer and deeper. Students need to engage with math concepts in a variety of contexts. Math concepts must be made personally meaningful to students in understanding the world and their own place in the world.

Elementary education should give children a sense of numbers as they occur in various contexts, such as measuring, chance, data, geometry and arithmetic. The concrete operations of arithmetic are no longer the main thing, but rather the conceptualization of the numerical character of aspects of reality has become central. Number sense is creative and personal, rather than mechanical. A child with number sense sees alternative ways to approach a problem and also has a sophisticated sense that the method of approach also has an impact on the answer. Number sense can be expressed orally, in writing and symbolically. Graphic or visual methods of expressing quantitative relationships must be understood and utilized by the child. Children with number sense can figure out the best method, out of the several usually available, to find the answer to the problem facing them. They know how to get useful results with a minimum of effort.

Students learn math only when they construct their own mathematical understanding. The best way to do this is by working in groups, discussing math problems with other students, presenting solutions to the class, and taking charge of their own learning. Students should feel comfortable with their own approach and be able to justify it in argument. Effective math classrooms need less "teacher talk" and more student engagement. Students need

time and space to be able to learn from their own trials and errors. Memorization is not central, but rather the key is understanding based on personal experience with math concepts.

Good math instruction takes time. A few concepts learned thoroughly, deeply, and personally are more useful than a wide variety of concepts learned in a shallow, perfunctory manner which will quickly fade from memory. Dade students are often bored with their math instruction, but math can be made interesting. The teachers can be taught hands-on activities to make it so.

Also, math is the prime academic villain in driving students out of college. Failure rates in math courses are the highest of any of the main academic subjects. Math in college is particularly difficult for women and minority students. [Tobias.] In order to continue to lower dropout rates (and to make college success possible for more women and minorities), a more solid grounding in math in the elementary years is essential.

A crucial problem is that Americans think that difference in performance in math are due mainly to inherent individual ability, rather than to differences in teaching effectiveness and individual effort. Americans typically overrate innate intelligence and underrate persistence. The consequences are serious: we do not take the necessary steps to improve teaching; we tolerate laziness on the part of students; and we write off the educational possibilities of all but the brightest students. This attitude is harmful to our country, because other countries, such as Japan, educate all of their students to a much higher level than all but a tiny handful of American students.

Some people in our society think that it is cute and endearing to be ignorant about math. The idea is widespread that only geniuses can do math. We expect that most students "can't do math", and so we engender low expectations and get the result which we predicted.

Many elementary teachers themselves never learned math properly. They consider that they are weak at math by some inherent personal quality. And

they are frightened by math and communicate this fear and distaste to their students. Studies have shown that elementary teachers smile much of the time while teaching language arts, but they seldom smile while teaching math because of their own discomfort with the subject. This effectively communicates an attitude of fear and dislike of math to the students.

Most elementary teachers have only taken one college course in mathematics or math education, even though four are recommended as the appropriate preparation. Math is second only to reading and writing in importances as an elementary subject, but most teachers are inadequately prepared for their math instructional obligations.

Math education is made more difficult in public elementary schools in that Florida state regulations require the teaching of such subjects as gun safety, consumer education, traffic education, environmental education, recycling of wastes, health education, substance abuse prevention, History of Florida, conservation of natural resources, kindness to animals, and the effects of alcohol and intoxicating liquors and narcotics. With all of these mandated subjects, there is very little room for reading, writing and arithmetic. [GCRE, pp. 35-36.]

The DCPS is now exploring the idea of making reading and writing the core goal of the school system, and math, science and computer skills and knowledge should be a strong second goal for our system. In order to concentrate on such central goals, the schools need relief from over-regulation by the Legislature, the state Department of Education, and the District administration. SBM/SDM is providing some such deregulation, but much more is needed. On the other hand, schools need clear guidance to encourage them to set high academic goals, and they need a clear system of rewards and penalties to motivate them to achieve. Above all, effective, professional principals and teachers are required if the children are to succeed.

SECTION ONE: STATISTICAL INDICATORS OF MATH PERFORMANCE.

Dade's students perform at about the same level as America's students generally in standardized math tests, unlike reading where local scores are significantly lower than the national average. Over the period since 1982 math scores have tended to rise in Dade County. The problem of math instruction here, then, is not that we are doing worse than the country overall, but that the nation's math performance is simply inadequate, as is Dade's. These scores indicate that Dade's public schools have the potential to do significantly better than the national averages in math performance, in spite of the large numbers of low-income, minority students and the influx of refugees and immigrants. If we are at the national norm today with our present math program, we could move significantly ahead of the national norm with a stronger math program.

The pattern in math scores over the past eight years has been mostly positive when looking at the countywide medians. The age cohorts have generally performed better in the higher grades than the lower grades, and each grade level has tended to improve over time. In other words, the group of students which enters the first grade in the fall of 1980 will tend to have higher Stanford scores as fifth graders when they take the test in the spring of 1985 than they did as first graders in the spring of 1981 (this is an age cohort). And the group of first graders taking the Stanford test in the spring of 1985 will tend to have higher scores than the first graders who took the test in the spring of 1981 (the grade level). So the improvement over time has two dimensions.

TABLE 1: COUNTYWIDE AGE COHORTS AND STANFORD MEDIAN PERCENTILES.

STUDENTS ENTERING FIRST GRADE IN YEAR:	G R A D E 1	2	3	4	5
MATH COMPUTATION:					
1982	40	55	51	53	62
1983	39	60	51	54	58
1984	44	55	51	54	57
1985	40	46	56	54	57
1986	46	66	56	54	--
1987	49	62	55	--	--
1988	49	66	--	--	--
1989	49	--	--	--	--
MATH APPLICATIONS:					
1982	--	42	53	51	50
1983	--	42	50	51	50
1984	--	40	53	55	52
1985	--	42	54	55	52
1986	--	46	57	55	--
1987	--	46	54	--	--
1988	--	46	--	--	--

STUDENTS ENTERING FIRST GRADE IN YEAR:	GRADE 1	2	3	4	5
MATH/NUMBER CONCEPTS:					
1982	35	51	54	55	52
1983	40	51	54	56	50
1984	40	51	59	56	52
1985	40	56	59	59	50
1986	49	61	64	59	--
1987	49	60	59	--	--
1988	51	61	--	--	--
1989	51	--	--	--	--

SOURCE: DCPS, District and School Profiles, 1982-83 through 1989-90.

****

Math Computation, the score used to help award QUIIP bonuses, shows the same pattern as Math Applications and Concepts of Number, which have no financial benefits attached. No clear pattern exists of generally higher scores for Math Computation, as opposed to Applications or Concepts of Number. If QUIIP had functioned effectively, higher scores across the board would be expected for Math Computation, since people were being compensated for this score. As it is, Computation scores are generally higher in fifth and second grades, but Concepts of Number has been higher in recent years in first, third and fourth grades. The funding for QUIIP was so low that it had little impact on student performance.

Table 2 shows the pattern in racial and ethnic groups for Math Computation scores in the past two years. All groups of students score higher in the fifth grade than they do in the first grade. For the all-grade average in 1989, Hispanics received only 81% and blacks only 59% of the white, non-Hispanic scores. Some of this is caused by differences in home environment, but we believe that the key cause is differences in school environment.

As can be seen in Table 2, Anglos are widening their lead over the blacks and Hispanics. African-American math scores are actually declining, while Hispanic scores are increasing at a slower rate than those of the Anglos. Since, as we will see below, student scores are high and rising in some low-income, minority schools and not in others, the problem is not with the students, but rather with some of the schools.

****

TABLE 2: MATH COMPUTATION MEDIAN PERCENTILES BY RACE AND ETHNICITY, 1988-89.

GRADE	WHITE		BLACK		HISPANIC	
	1988	1989	1988	1989	1988	1989
1	63	67	39	36	54	54
2	78	82	50	50	62	67
3	69	69	45	45	59	59
4	70	72	41	41	56	57
5	72	73	45	45	58	58
ALL-GRADE AVERAGE	70	73	44	43	58	59
SHIFT		+3		-1		+1

SOURCE: DCPS, **District and School Profiles, 1988-89, 1989-90.** All-grade averages and shifts our calculations.

**********TABLE 3: MATH COMPUTATION MEDIAN PERCENTILES BY GENDER.

GRADE	MALE		FEMALE	
	1988	1989	1988	1989
1	49	48	53	49
2	60	62	66	67
3	55	51	59	59
4	51	51	57	60
5	54	54	62	62
ALL-GRADE AVERAGE	54	53	59	59
SHIFT		-1		0

SOURCE: DCPS, **District and School Profiles, 1988-89, 1989-90.** All-grade averages and shifts our calculations.

As seen in Table 3, girls start out ahead of boys and widen their lead by fifth grade. Boys score lower than girls, and their score is tending to decline. In the low-income, African-American schools, boys often score at only half the level of girls. In later grades, boys will pull ahead of girls, and by college, girls will have a low rate of taking and succeeding in math courses. Schools need to find ways to build upon the math successes of girls in the elementary grades.

Next, in Table 4, schools which stand out, either positively or negatively, will be examined. These schools are "outliers", that is they have residuals which are the most positive or negative within their group. They "lie outside" the normal range. The elementary schools were divided into three groups by socio-economic status. High-income schools were schools in which less than 33% of the students received reduced or free lunch. Medium-income schools had 33-67% of their students on reduced or free lunch. And low-income schools had 67-100% of their students on reduced or free lunch. Five positive and five negative outliers were chosen in each group, according to the strength of the 1989 residual in the Stanford Math Computation test.

These statistics demonstrate that good results and bad results are achieved by schools in every income category. Much depends on the principal and the school staff. The specific programs of the schools with strong, positive residuals will be discussed, along with the general problems in the schools with negative residuals, without identifying the particular school with the particular problems. Our interest is not in fixing problems in

TABLE 4: OUTLIER SCHOOLS:

SCHOOLS:	% LOW INCOME	TEST	SCORES 1988	SCORES 1989	SCORES SHIFT	RESIDUALS 1988	RESIDUALS 1989	RESIDUALS SHIFT
HIGH INCOME:								
POSITIVE:								
NORTH BEACH	25	COMP	86	89	3	24.6	**22.2**	-2.4
		APPL	82	81	-1	16.1	3.6	-12.5
		NUMB	89	86	-3	----	----	----
MODERN LANG	19	COMP	--	85	--	----	**16.8**	----
		APPL	--	85	--	----	14.0	----
		NUMB	--	82	--	----	----	----
CYPRESS	11	COMP	73	79	6	2.5	**16.1**	13.6
		APPL	76	75	-1	1.6	3.8	2.2
		NUMB	78	83	5	----	----	----
WEST LAB	10	COMP	75	74	-1	6.6	**15.8**	9.2
		APPL	80	83	3	-0.1	9.4	9.5
		NUMB	81	84	3	----	----	----
PINECREST	7	COMP	86	85	-1	15.6	**13.2**	-3.4
		APPL	86	88	2	10.8	8.5	-2.3
		NUMB	88	90	2	----	----	----
NEGATIVE:								
REDLAND	24	COMP	55	50	-5	-6.1	**-14.7**	-8.6
		APPL	64	62	-2	-1.8	-4.5	-2.7
		NUMB	61	63	2	----	----	----
OJUS	15	COMP	65	64	-1	-6.9	**-11.1**	-4.2
		APPL	76	78	2	6.2	2.4	-3.8
		NUMB	66	69	3	----	----	----
MIAMI SPRNGS	25	COMP	62	59	-3	-2.2	**-5.3**	-3.1
		APPL	65	61	-4	2.9	-3.5	-6.4
		NUMB	66	69	3	----	----	----
PALM SPGS N	20	COMP	51	55	4	-11.7	**-3.7**	8.0
		APPL	58	58	0	-4.6	-0.7	3.9
		NUMB	55	57	2	----	----	----
BLUE LAKES	16	COMP	66	62	-4	-0.6	**-3.6**	-3.0
		APPL	66	62	-4	-1.6	-3.3	-1.7
		NUMB	68	68	0	----	----	----

SCHOOLS:	% LOW INCOME	TEST	SCORES 1988	SCORES 1989	SCORES SHIFT	RESIDUALS 1988	RESIDUALS 1989	RESIDUALS SHIFT
MIDDLE INCOME:								
POSITIVE:								
CRESTVIEW	42	COMP	57	65	8	4.8	**17.1**	12.3
		APPL	42	45	3	-2.2	5.4	7.6
		NUMB	43	45	2	----	----	----
GREYNOLDS PK	36	COMP	69	76	7	4.1	**15.2**	11.1
		APPL	69	69	0	-1.0	8.9	9.9
		NUMB	72	76	4	----	----	----
COLONIAL DRIVE	52	COMP	42	56	14	1.6	**14.5**	12.9
		APPL	48	50	2	3.8	4.3	0.5
		NUMB	49	52	3	----	----	----
MYRTLE GROVE	61	COMP	62	64	2	9.4	**14.4**	5.0
		APPL	50	50	0	1.9	5.0	3.1
		NUMB	56	56	0	----	----	----
SEMINOLE	56	COMP	48	72	24	-9.0	**13.9**	22.9
		APPL	51	55	4	-0.9	4.2	5.1
		NUMB	49	73	24	----	----	----
NEGATIVE:								
KENSINGTON PK	60	COMP	56	59	3	-5.5	**-8.9**	-3.4
		APPL	50	47	-3	-7.0	-3.6	3.4
		NUMB	59	61	2	----	----	----
CUTLER RIDGE	42	COMP	59	54	-5	1.5	**-8.3**	-9.8
		APPL	62	50	-12	5.2	-8.0	-13.2
		NUMB	61	60	-1	----	----	----
MOTON	45	COMP	60	55	-5	-0.5	**-7.7**	-7.2
		APPL	62	60	-2	3.5	-2.2	5.7
		NUMB	56	--	--	----	----	----
NARANJA	64	COMP	39	39	0	-8.1	**-5.2**	2.9
		APPL	40	41	1	-1.6	-8.9	7.3
		NUMB	38	43	5	----	----	----
SYLVANIA HTS	40	COMP	59	61	2	-3.6	**-5.1**	-1.5
		APPL	62	62	0	-2.7	-1.2	1.5
		NUMB	61	63	2	----	----	----

SCHOOLS:	% LOW INCOME	TEST	SCORES 1988	1989	SHIFT	RESIDUALS 1988	1989	SHIFT
LOW INCOME:								
POSITIVE:								
CAMPBELL DRIVE	69	COMP	55	64	9	-2.2	**12.7**	14.9
		APPL	55	57	2	-7.3	3.5	10.8
		NUMB	61	64	3	----	----	----
BEL-AIRE	68	COMP	51	57	6	2.1	**11.5**	13.6
		APPL	47	47	0	0.9	4.1	3.2
		NUMB	59	51	-8	----	----	----
GOLDEN GLADES	72	COMP	49	50	1	1.3	**6.4**	5.1
		APPL	39	38	-1	0.2	-0.3	-0.5
		NUMB	50	44	-6	----	----	----
CHARLES DREW	71	COMP	49	48	-1	4.2	**4.7**	0.5
		APPL	39	44	5	-1.2	9.8	11.0
		NUMB	50	47	-3	----	----	----
OLINDA	82	COMP	34	41	7	-7.4	**3.6**	11.0
		APPL	35	35	0	-1.0	-1.6	-0.6
		NUMB	32	46	14	----	----	----
NEGATIVE:								
MARTIN L KING	92	COMP	44	26	-18	-1.1	**-18.3**	-17.2
		APPL	39	22	-17	-6.3	-17.2	-10.9
		NUMB	49	31	-18	----	----	----
A. L. LEWIS	93	COMP	25	24	-1	-11.6	**-16.5**	-4.9
		APPL	28	25	-3	-3.1	-7.8	-4.7
		NUMB	30	26	-4	----	----	----
LITTLE RIVER	92	COMP	34	27	-7	2.5	**-15.5**	-18.0
		APPL	30	23	-7	-1.4	-10.5	-9.1
		NUMB	35	26	-9	----	----	----
LILLIE EVANS	85	COMP	28	25	-3	-18.0	**-15.2**	2.8
		APPL	21	19	-2	-11.6	-11.2	0.4
		NUMB	26	22	-4	----	----	----
BUENA VISTA	96	COMP	53	50	-3	5.5	**-14.5**	-20.0
		APPL	42	22	-20	-4.0	-24.5	-20.5
		NUMB	61	35	-26	----	----	----

SOURCE: DCPS, **District and School Profiles, 1988-89, 1989-90.** Shifts our calculations.

individual schools, but in developing good District-wide policies.

Crestview has the most exciting math program, because of their schoolwide writing emphasis which is incorporated into math instruction in a very effective manner. Students do several math problems, correct them and then write about what they got wrong and why. They also make up stories which contain math problems and then solve them. Students work cooperatively in groups of four to solve problems and explain them to each other. Pop quizzes are frequent, brought from class to class by the "Math Lady" who has a cart with tapes of problems. She gives rewards for success. Crestview has made up tapes in which the multiplication tables are set to rap music. Crestview involves the parents in workshops and four times a year sends home booklets with instructions on how the parents can help the students with homework. Crestview's program—because of its writing emphasis—seems better designed to imbue students with true understanding of math operations than any other program in the county.

West Laboratory School also has a very exciting math program. At every grade level, math is taught by specialists with special training and a love for the subject. Work with manipulatives and hands-on projects are emphasized. The classrooms are well stocked with equipment to provide exciting math lessons at every level. Students work on individualized programs, often with several students at the same level advancing together in little clusters. West Lab emphasizes a deep understanding of math and de-emphasizes mere rote learning.

Cypress had a QUIIP program focused on math in 1988-89. One staff member dressed up as a dog, known as "Math Mutt", and came around to each class and had the students do problems. Successful students received doggie bones as an award, and these could be turned in for prizes at the math fair later in the year.

North Beach Elementary has the strongest positive residuals among the high-income schools, even though its student body is one-fourth low income. This school has been widely recognized for its very active principal and its committed staff. Among the programs which it used in 1988-89 to raise math achievement were: Saturday school for 16 weeks for 250 students, geared especially for low-achieving students; cooperative learning teams which participated in math contests throughout the year; review and test preparation all year round; games and role playing in math activities; a model bank, with passbooks for the students and math activities associated with deposits and withdrawals; writing across the curriculum, including writing about math; and an emphasis on gamelike drill activities. Manipulatives will be given greater attention next year.

At Pinecrest, basic skills are emphasized, with much test preparation for the children. Students at Pinecrest tend to do better on Math Applications and Concepts of Number than on Math Computation, because they are sometimes careless in the details of computation, so the need for care is emphasized. Math in fifth and sixth grades is departmentalized, with special teachers for math who either have had extra college courses or enjoy the subject. Manipulatives are widely used in the early grades.

Myrtle Grove is a middle-income African-American school which is operating under SBM/SDM. They have made many innovations, including "The Wheel", a program by which second and third graders are given an hour of intensive reading instruction each day by giving half of each class other activities (physical education, art, music, computers, self-esteem), while the other half take reading and vice versa. Their success points out the possibilities of using SBM/SDM for student achievement gains.

Seminole tests students weekly on targeted math skills, with an emphasis on problem-solving and applications. The school leadership closely tracks results in each class.

Greynolds Park in 1988-89 had a schoolwide QUIIP project focused on math. They had a math-computer fair, and students earned rides and prizes based on answering math problems correctly. Parents received learning packets from the school. About half the teachers in the school are using manipulatives, including tangrams, attribute blocks and counting sticks.

At Colonial Drive, each Friday, students in each grade do Math Fun Facts, with four or five problems to be answered by each. Winners are announced over the PA system and cheered. Word problems in math are emphasized, and the students act out the problem. Children are encouraged to put math problems in their own words, in order to facilitate understanding. Peer tutoring is widely practiced, and students sometimes are better able to teach other students than adults are.

Campbell Drive Elementary in 1988-89 switched to using **Scoring High** every day in order to do better on the Stanford test. The emphasis is on drill and rote memory of computational facts.

Bel-Aire ran a weekly math contest in computational skills, with certificates given out to the "Math Whizzes". Felt boards are used to illustrate number sentences.

As we have seen, very different methods are used to attain positive residuals. Some of these methods are more in keeping with the aim of developing a deep understanding of math than others. The most effective schools are emphasizing writing about math, hands-on activities, work with manipulables, cooperative learning, and departmentalized instruction by trained experts in math.

Some of the schools which had strongly negative residuals in 1988-89 have added programs within the 1989-90 school year which are intended to overcome their earlier weakness. Moton is making math the focus of its QUIIP project and has instituted a school bank and a weather station. The weather station offers students hands-on opportunities to unify math and science, exactly the

kind of innovative program which should make students interested in math as a problem-solving tool.

Buena Vista has a math QUIIP thrust, with a math carnival in June, math games every day, and math bees several times a year. Each teacher has manipulatives and uses them: little clocks for telling time; play money; shapes; rulers; and flannel boards.

A. L. Lewis is also focussing on math for QUIIP. Math instruction has been departmentalized in the fourth and fifth grades, with teachers who like math and who are being given stipends to attend further courses in math. In the summer, a writing through math program allows students to write out why they missed problems and keep a book of math definitions and formulae. For next year, manipulatives have been ordered through Chapter I and teachers will be taught how to use them by the regional math coordinator. Kindergarten and first grade students are exposed to on-grade math skills and drill each morning, but in the higher grades where students are performing far below grade level, the use of on-grade math skills and drill does not work. Lewis went off the deficient list for fourth grade math on the SSAT this year.

Miami Springs Elementary participates in the Math Superstars Program, in which students are given difficult math problems to solve as homework. The problems are one grade level above the students. Parent volunteers administer the program. The third grade teacher also organized a math super bowl, with playoffs between different levels.

Ojus is grouping students by ability in math and has added five math specialists as teachers, one who is specially trained and four who love math. On Fridays, students do Math Superstars. The principal encourages teachers to use manipulatives in teaching math. Several ineffective teachers who helped to bring down the math scores have been let go.

Kensington Park has reassigned ineffective teachers so that they will no longer teach math. Next year the school will begin emphasizing the use of manipulatives in teaching math.

Among the schools with strongly negative residuals, principals and assistant principals very commonly stated that their school had no special math program. The school was simply carrying out the county TMP curriculum. The school did not encourage students through games and contests or use manipulatives to any great degree. Some principals indicated that a number of their teachers were weak in as math instructors and that this caused the low residuals of their schools. They were able to pinpoint the weakness to teachers in certain grades which had the most negative residuals. However, these principals sometimes did not indicate that they were doing anything to strengthen these teachers or to replace them. In other cases, principals attributed poor results to teacher absences, pregnancies, the presence of new teachers, or the existence of a low-scoring class. When the principal gave excuses like these and did not indicate that there was any schoolwide effort to improve math instruction, the excuses sounded inadequate.

Another common difference between successful and unsuccessful schools was in grouping practices. Unsuccessful schools were more likely to emphasize homogeneous grouping of students than the successful schools. Unsuccessful schools concentrate their best resources on a few of the better students and effectively write off the mass of average and poor students.

Schools with negative residuals were less likely to compete in QUIIP or to consider QUIIP a fair program. Again, principals were inventive with reasons why their school did not have a fair chance in QUIIP. These excuses were not, however, accompanied by a well-planned effort to win QUIIP.

In a number of the schools with negative residuals, informed sources within the DCPS indicate, a pattern has existed for the past thirty years of a willingness to accept transfer teachers from other schools who have gotten into difficulties because of weaknesses in basic skills, subject matter knowledge and teaching techniques. Over time, these schools have developed sizeable clusters of teachers who would not function well in schools with demanding standards.

Several of the principals in schools with negative residuals did not seem to be in command of their jobs, i.e., they gave no evidence of providing instructional leadership. For example, their schools were performing very badly in math, yet the principal was not bringing in new programs which were intended to overcome this deficiency. They were passively going along with the countywide TMP curriculum and taking no measures to meet the special needs of the students in their school.

The DCPS has made considerable progress over the past three years by reassigning or inducing early retirement in ineffective principals. We are pleased to hear that many principals are being transferred or moved out of the principalship this summer, including a number of who have been associated with negative reading and math residuals on the Stanford Achievement Test over the past several years. This must continue. With SBM/SDM, the principalship must be occupied by effective instructional leaders.

A problem obviously also exists with teacher quality in many of the low-scoring schools. Teachers who could not succeed in more effective schools were sent to these schools. The results are apparent in very negative residuals, alongside very low scores. And grade-level scores and residuals are often far worse (and far better) than school-wide scores, indicating very specific problems within the school in terms of teacher quality.

COMPUTING RESIDUAL SCORES MORE ACCURATELY.

The residual scores for these schools indicate that the numbers reported in **District and School Profiles** are not fair, because the residuals do not control for family income. It turns out to be much more difficult for low income schools to gain high positive residuals than it is for high income schools

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TABLE 5: AVERAGE RESIDUALS.

	POSITIVE OUTLIERS	NEGATIVE OUTLIERS
HIGH INCOME	17.4	5.6
MIDDLE INCOME	8.4	11.8
LOW INCOME	8.3	13.7

SOURCE: DCPS, **District and School Profiles, 1989-90.** Our calculations.

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If the residuals were accurate and fair, the average positive and negative residuals of the groups of schools would be the same for every income level. These residuals do not account for family income, but only race/ethnicity, gender, grade, and previous test scores. Adding family income would increase the predictive value of the residuals. It would be best to put in the percentage of low-income students in the school as part of the residuals, since there are school-level effects, as well as individual-level effects.

The residuals reported in **District and School Profiles** are not the same residuals as those which were used to calculate the Merit School (QUIIP) bonuses, which controlled for socio-economic status as indicated by free and reduced lunch. The QUIIP residuals were therefore fairer and more accurate than those reported here. The residual formula used for QUIIP should be reported in **District and School Profiles**, since this would help in our efforts to make QUIIP more acceptable to teachers. And the residuals in **District and School Profiles** should be as fair and accurate as possible, because of the many uses to which Dade Countians put this book, including choosing neighborhoods in which to buy homes. If families pay attention to the residuals, they could be buying homes that they cannot afford without knowing that schools in more affordable neighborhoods also have very good residuals when socio-economic variables are included. As it stands, the residuals reported here are harming families with children.

MATH IN SBM-SDM ELEMENTARY SCHOOLS.

Let us now look at the math performance in the SBM/SDM elementary schools. For the sake of simplicity, we will confine ourselves to residual shifts between 1987 and 1989 in the Math Computation scores.

The results for the elementary SBM/SDM schools are more positive than for the secondary SBM/SDM schools. Obviously there are greater problems in using SBM/SDM to improve student achievement in secondary schools than in elementary schools. The school has a larger impact on elementary students than on secondary students, since peers and jobs play a larger role in the lives of older students.

For math computation, the two year residual shift for all SBM/SDM schools is -0.4, while the residual shift in the elementary schools alone is a +0.4. We are concerned that in the SBM/SDM elementary schools that all of the gains were in the first year of the experiment, while there was a decline in the residuals in the second year. SBM/SDM, as it is presently constituted, is inadequate in improving student achievement. As the national and state educational summits pointed out, greater financial motivation is required if teachers are to exert themselves for really significant, sustained gains. More curricular direction is also needed, such as requiring writing portfolios, including writing on math, for each student.

TABLE 6: MATH RESIDUALS IN SCHOOL-BASED MANAGEMENT/SHARED DECISION-MAKING SCHOOLS.

	RESIDUALS			RESIDUAL SHIFTS		
SCHOOL	1987	1988	1989	87-88	88-89	87-89
BRYAN	-10.0	-7.3	-3.9	2.7	3.4	6.1
BUNCHE PARK	0.8	-0.2	-12.8	-1.0	-12.6	-13.6
CAMPBELL DRIVE	-3.4	-2.2	12.7	1.2	14.9	16.1
CHAPMAN	-3.9	-5.5	-1.6	-1.6	3.9	2.3
COCONUT GROVE	11.1	3.8	9.4	-7.3	5.6	-1.7
CUTLER RIDGE	-0.3	1.5	-8.3	1.8	-9.8	-8.0
FAIRCHILD	-3.5	3.2	3.7	6.7	0.5	7.2
HADLEY	-2.3	2.8	9.1	5.1	6.3	11.4
HOOVER	4.8	6.5	5.1	1.7	-1.4	0.3
KENDALE	15.2	5.0	9.1	-10.2	4.1	-6.1
LITTLE RIVER	-9.5	2.5	-15.5	12.0	-18.0	-6.0
MIAMI LAKES	-1.9	2.3	4.3	4.2	2.0	6.2
MOTON	-7.9	-0.5	-7.7	7.4	-7.2	0.2
MYRTLE GROVE	7.3	9.4	14.4	2.1	5.0	7.1
NORTH MIAMI	6.1	7.9	4.2	1.8	-3.7	-1.9
OLYMPIA HEIGHTS	12.6	1.7	0.2	-10.9	-1.5	-12.4
PALMETTO	6.3	5.9	0.8	-0.4	-5.1	-5.5
PERRINE	-7.6	-11.2	-1.8	-3.6	9.4	5.8
AVERAGE SBM/SDM:	0.8	1.4	1.2	0.6	-0.2	0.4

SOURCE: DCPS, **District and School Profiles, 1987-88, 1988-89, 1989-90.** Averages and residual shifts our calculations.

SECTION TWO: IMPLEMENTING THE NATIONAL STANDARDS LOCALLY.

The National Council of Teachers of Mathematics is preparing new standards for teaching math. In grades K-4, their new standards include the following:

STANDARD 1. MATHEMATICS AS PROBLEM SOLVING.

In grades K-4, problem solving should permeate the mathematics curriculum so that students can:
—use problem-solving processes in their learning of all mathematical content;
—use strategies in solving a wide variety of problems from many contexts;
—discuss alternative solution strategies and relationships among problems;
—formulate problems.

The NCTM believes that children learn math best through solving problems. Math should not be taught as an abstract skill, but should be related to the context of a problem. Math should be made relevant to children, and they should gain confidence in solving problems. Problems for students in primary grades should result from everyday situations. Problems should be represented in many forms, such as pictures, diagrams, graphs, and number sentences. Since different children have different learning styles, all should be exposed to a variety of ways of representing problems.

STANDARD 2. MATHEMATICS AS COMMUNICATION.

In grades K-4, oral language and representations should permeate the mathematics curriculum so that students can:
—build meanings of concepts and procedures;
—use a variety of representations to solve problems and validate hypotheses;
—develop a language, including symbols, to communicate and extend mathematical ideas.

Math is a kind of a language. Children need to be exposed to various physical, pictorial, symbolic and mental representations so that they can link the abstract language of math with their informal, intuitive notions. Teachers should ask probing questions and watch for possible misconceptions.

Talking, listening, reading, and writing are an integral part of math instruction in the elementary grades.

STANDARD 3. MATHEMATICS AS REASONING.

In grades K-4, reasoning should permeate the mathematics curriculum so that students can:
—extend patterns and find relationships;
—explain their thinking and justify solutions using models, known facts, properties and relationships;
—use empirical validation as an integral part of their daily mathematical experience.

Children need to learn that math is logical and that they can explain and valid their own math understanding. Critical thinking should be at the heart of math instruction. All statements should be subject to question. The ideas of the children should be treated with genuine respect.

STANDARD 4. ESTIMATION.

In grades K-4, the curriculum should include estimation so students can:
—explore estimation strategies;
—recognize when an estimate is appropriate;
—use estimation to determine reasonableness of results;
—apply estimation in working with quantities, measurement, computation, and problem solving.

Students need to learn to use reason, judgement, and decision-making in estimation. Children already do estimates when they enter school, but they need to understand the process of estimation in a more formalized sense. Children should use estimation to determine if the results which they get from the calculator are approximately correct or absurd.

STANDARD 5. NUMBER SENSE AND NUMERATION.

In grades K-4, the mathematics curriculum should include whole number concepts and skills so that students can:
—construct number meanings through real world experiences and physical materials;
—understand our numeration system by relating counting, grouping, and place value concepts;
—develop number sense;
—interpret the many uses of number encountered in the real world.

"Children who have acquired a good number sense have well understood number meanings, have developed many relationships among numbers, recognize the

relative magnitudes of numbers, and the relative effect of operating on numbers." Number meanings are gradually acquired from physical situations. Students need to be exposed to many such situations and given the time necessary to assimilate them. Children should work with physical materials extensively before being exposed to symbols. And symbols should be related to concrete experiences. Extensive use of manipulatives for grouping should precede numbers.

STANDARD 6. CONCEPTS OF WHOLE NUMBER OPERATIONS.

In grades K-4, the mathematics curriculum should include concepts of addition, subtraction, multiplication, and division of whole numbers so that students can:
—represent and discuss a rich variety of problem situations using informal language and physical materials prior to explicit instruction on the four operations;
—relate problem situations, models, number sentences, operations, and the accompanying mathematical language;
—develop operation sense.

Children should apply addition, subtraction, multiplication and division to real-world situations. They should experience these operations informally in problem situations before being exposed to the symbols for the operations. Students should not write number sentences until they can solve problems fluently and with understanding.

STANDARD 7. COMPUTATION.

In grades K-4, the mathematics curriculum should include whole number computation so that students can:
—model, explain, and develop reasonable proficiency with basic facts and algorithms;
—invent and use a variety of paper-and-pencil algorithms and mental arithmetic techniques;
—estimate results;
—use calculators as a computational tool;
—select and use an appropriate way to compute a problem situation and determine whether the result is reasonable.

Too much emphasis on computation deprives the children of the right to learn about more math concepts. The concepts of computation, not rote operations, should be emphasized. Computation should take place to solve everyday problems. Computation skills should not be introduced prematurely, before the students have understood the basic concepts through work with manipulatives

and oral discussion. The focus of the curriculum should not be on rule for carrying out computation procedures.

STANDARD 8. MEASUREMENT.

In grades K-4, the mathematics curriculum should include measurement so that students can:
—understand measurable attributes, the concept of a unit, and the process of measuring;
—make and use measurements in problem and everyday situations;
—make and use estimates in measurement situations.

Measurement naturally extends children's concept of number. Measurements should include length, capacity, weight/mass, area, volume, temperature, time, and angle. The Logo computer program can be used to create angles through rotations.

STANDARD 9. GEOMETRY AND SPATIAL SENSE.

In grades K-4, the mathematics curriculum should include two- and three-dimensional geometry so that students can:
—describe, model, and classify shapes;
—investigate and predict results of combining, subdividing, and changing shapes;
—develop spatial sense;
—relate geometric ideas to numeric and measurement ideas;
—use geometry in solving problems.

Children have a natural interest in geometry and find it intriguing and motivating. Children need to investigate, experiment and explore, using everyday objects and other physical materials. Children should understand relationships and not simply memorize terms and definitions. Children should make models from straws and draw and manipulate shapes on the computer screen. They should fold paper cutouts and use mirrors to see which shapes have line symmetry.

STANDARD 10. STATISTICS AND PROBABILITY.

In grades K-4, the mathematics curriculum should include statistics and probability so that students can:
—collect, organize, and display data;
—use data to make and check predictions;
—experiment with concepts of chance;
—apply statistics to solve problems.

Primary grade children can collect and graph data. They can use bar, line, and picture graphs. Five-year-olds can graph shoes by lining them up on

the floor to determine what kinds of shoes are most heavily represented in the class.

STANDARD 11: FRACTIONS AND DECIMALS.

In grades K-4, the mathematics curriculum should include fractions and decimals so that students can:
—develop concepts of familiar fractions, mixed numbers, and decimals to tenths;
—extend number sense to include fractions and decimals;
—use models to relate fractions to decimals and to find equivalent fractions;
—use models to explore operations on fractions and decimals;
—apply fractions and decimals to problem situations.

It is important for elementary students to learn how fractions and decimals work in relation to whole numbers, but it is not necessary that they devote themselves at length to multiplying and dividing the less frequently encountered fractions. Research demonstrates that this is seldom required in adult life. There are better things for students to be doing in math than obscure operations with fractions.

STANDARD 12: PATTERNS, RELATIONS, AND FUNCTIONS.

In grades K-4, the mathematics curriculum should include patterns, relations, and functions so that students can:
—describe, extend, and create a wide variety of patterns and functional relationships;
—represent and describe relationships between quantities;
—use intuitive methods, inverse operations, and/or other mathematical relationships to find solutions to open sentences. [NCTM.]

By these means, elementary students will be prepared to encounter algebra in middle school. They will understand the basis of functions.

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These standards represent the state of the art in elementary math instruction today. In some school districts around the country, these standards are being achieved. It is possible to achieve these standards, even in a predominantly minority district with a large number of students from low-income students. Here are our recommendations for implementing these standards locally.

RECOMMENDATION 1: Hands-on math projects should be undertaken at every stage of instruction. Such activities include the use of manipulatives, games and other means of making math real and personal to the students. Active and personalized methods for teaching math are particularly necessary in low-income schools. Even though such activities are called for in the District's Total Mathematics Program (TMP) and in most of the other math systems in use in the DCPS, these activities are not actually being carried out by many of the teachers in the schools. Closer monitoring of math instruction by principals and peers is needed to assure that appropriate hands-on activities are being used. TADS observations should be made out during elementary math classes, as is seldom done today.

Hands-on projects involve measuring, counting, estimating, visual displays of mathematical relationships, and the like. Commercially available materials, such as AIMS and others, include a comprehensive series of hands-on math activities for students at every level. As we have seen, the most effective schools in Dade County are already using these methods.

The math textbooks in use in Dade County are largely "teacher proof", i.e., they allow even very poorly educated teachers to do a minimally effective job of teaching math if they follow the guidelines carefully. They spell out everything the teacher is to say and do with the children. Since we continue to have a large number of poorly prepared teachers in our District, we continue to need to spell out a minimal curriculum for the teachers, although we should strive to encourage teacher—and collective school staff—creativity and going beyond the minimum.

Unfortunately, even though the curriculum series in use in Dade County do include plenty of hands-on activities and work with manipulatives as part of their recommendations to teachers, many teachers themselves are not using this

part of the overall package. These curricula are not "teacher-proof" enough, it seems. Many teachers do not want to involve themselves in more active teaching and prefer workbooks and ditto sheets. Part of the problem is that the teacher guidebooks make hands-on activities optional, and part of the problem is that the teachers do not feel comfortable with active math teaching.

Only if principals and peer evaluators become more involved in ensuring that the hands-on activities called for in the curricula are actually carried out by the teachers can we expect students to learn math in a deep, rich, and personally relevant fashion.

RECOMMENDATION 2: Manipulatives should be used widely. All elementary teachers with responsibilities for math instruction should be trained in the appropriate manipulatives and have access to them in the classroom. The use of manipulatives should be given special emphasis in schools with a preponderance of low-income students.

Many teachers are not making extensive use of manipulatives to illustrate math relationships. Partly, this is due to teacher unfamiliarity with how to use manipulatives effectively in teaching. Partly it is because some teachers find it more convenient to rely on passive seatwork—where students fill out ditto sheets or workbooks—than to engage in active direct instruction. Principals and governing councils of schools need to make the acquisition of appropriate manipulatives a priority in school budget decisions.

We would like to see more use of complex and beautiful manipulatives, such as Cuisenaire Rods—small, colorful blocks in precise metric lengths—which give children a sense of the intricacy and aesthetics of mathematical relationships. Few schools possess many sets of Cuisenaire Rods, and fewer teachers actively use them. Teachers need to be trained in their proper

use. The TMP should be revised to suggest the use of Cuisenaire Rods in kindergarten and first grade classes and should explain to teachers how to use the rods. Too many principals and teachers consider that only gifted children can really understand mathematical relationships and that rote drill is good enough for the rest.

RECOMMENDATION 3: The use of workbooks and ditto sheets should be minimized. Students should not be spending large amounts of time in unsupervised, individual seatwork. Any use of workbooks and dittos should be under the active supervision of the teacher. She or he should be circulating among the class while they are doing this work or teaching another group. Every page of workbook and ditto work should be marked right away by the teacher so that the student does not perpetuate errors. Preference should be given to more active and interesting methods of instruction than workbooks and dittoes.

District intervention is required to change this unfortunate teaching practice. Many teachers—particularly in low-income, minority schools—frequently sit at their desks and do not engage with the class for long periods of time. Closer supervision by principals and peers is required to ensure that teachers are actively engaged in direct instruction for most of the day. A more legitimate occasion for seatwork is when a teacher is busy with one group of students, while the students in other groups do seatwork with dittoes and workbooks.

Since the teacher does not frequently check the work of the students, a student can go on making an error over and over for a long time before it is discovered. This means that the student is having false ideas imprinted on his or her mind through repetition and it will be very difficult to unlearn this false idea and substitute a correct understanding later. Interactive computer learning would be one way to achieve the same objective more success-

fully. But the best way would be to have the students engaged in more active projects, including work with manipulatives and cooperative activities with other students.

RECOMMENDATION 4: Each student should own a calculator and have it available in math class daily. Business partners should be asked to pay for the calculators.

Calculators should be used for most complex math operations. Frequent manual repetition is not the best way to teach the students about the real tranformational processes and relationships involved in math operations. Hands-on math activities accomplish this much more successfully. The use of calculators is appropriate for elementary students. Children need to know when to find an exact answer and when to estimate. They need to know how to estimate plausible answers in order to check the likely reliability of an answer obtained from the calculator. And they need to know how to do simple problems in their minds. [NRC, p. 47-48.]

THE ROLE OF COMPUTERS.

Serious efforts are needed to overcome inequities in the assignment and usage of computers. Around the nation, low-income and minority schools have fewer computers than high-income, white schools. Minorities and women are more likely to use computers for drill and less likely to program than white males. Low-income, minority schools are less likely to have skilled computer teachers than high-income, white schools. [Anderson; McPhail.]

From our observations, there is every reason to believe that much of this is also true in Dade County today. There may be more computers in Chapter One schools than in other schools due to federal funding, but the use to which

computers are put is more likely to be toward low-order cognitive skills in inner-city schools than in the suburbs. And gender bias in computer programming is likely to persist unless strong efforts are made to overcome it.

RECOMMENDATION 5: Computers should be used primarily for higher order cognitive activities, rather than basic skills drill. Even very young elementary students have the ability to engage in more creative, interactive work with computers. Computer programs in the LOGO and BASIC languages lend themselves readily to interactive work by elementary students. Through such programs, students can deal conceptually with mathematics in many new ways. They can also do computer graphics and word processing.

Obviously, much of the problem stems from a lack of computer knowledge on the part of teachers themselves. However, computer software is often simple enough so that it almost teaches both the teachers and the students as they go along. One fundamentally incorrect idea which is widely prevalent in regard to computers, as with math generally, is that higher order cognitive skills are possessed only by a small minority of brilliant students and teachers and that the rest should be confined to rote drill.

Greater efforts are necessary to ensure that computer programs for students are appropriate. We have witnessed students working with basic skills drill programs which were set at too fast a speed. The students rarely succeeded, so they gave up in frustration.

SECTION THREE: WRITING PORTFOLIOS AND STAFFING.

According to the national coalition opposing standardized testing, which includes both the American Federation of Teachers, the National Education Association, and the National Association for the Advancement of Colored People, too much weight is placed on too limited a body of material in a test during too limited a period of time. If there were four or five tests, covering a total of eight to ten hours, and spread out over the whole year, then the test results would be more substantial and reliable, but the testing process itself would have a severely detrimental impact on the school's overall performance.

Even many schools with high residuals and scores are teaching to the Stanford test. The use of **Scoring High** is widespread throughout the DCPS, and this has been shown to be so close to the Stanford test that its use constitutes cheating. More flagrant cheating also takes place.

High stakes standardized testing puts a premium on rote memory and computational skills, rather than a deeper conceptual understanding of math. Standardized tests trivialize learning. Rote drill bores students and turns them away from an interest in learning. Low-income, minority students are made more likely to drop out of school because of the drill and skill focus.

Some schools gain high scores by making rote drill into a game with rewards. They do not find ways of teaching which make learning intrinsically interesting. They simply sugar coat the pill of boring drill with animals, clowns, computer games, math carnivals and the like. Students would learn and remember more math if we were building a real structure of understanding in their minds through hands-on activities, rather than teaching in a way which inspires no true love of learning and no real joy in discovery.

The best schools, such as Crestview and West Lab, teach math through writing and hands-on approaches. These schools get across maximum student

comprehension. They earn their high scores on the Stanford honestly, through students who really understand math, rather than through teaching to the test. The practices in these schools must become the practices of the District. In order to encourage this, we need to construct a new bonus system based on a broad, holistic assessment of the school.

RECOMMENDATION 6: Writing of each student should be collected each year in two portfolios which would be used in evaluating the student, the teacher and the school. The first portfolio would deal with literature and social science and the second with math and science. Math writing would include discussions of hands-on activities and word problems. Students would also discuss problems in which they got answers wrong. Precision of language in dealing with math concepts should be emphasized in evaluating these writings. By the requirement of writing portfolios for each student, each teacher and school will thereby be guided toward teaching math at least partially through writing.

Portfolios of student writing could be randomly sampled for each school. Enough essays could be evaluated for each school to give a statistically reliable sample. This would keep evaluation costs to a minimum. The evaluator could give a holistic numerical grade to each essay, based on grade level. These could then be controlled for income, race/ethnicity, gender, mobility, and previous student scores to produce a residual score for the school.

Collecting portfolios would not be optional. This would be required of each school. This is very much in line with the District's central objective of improving reading and writing abilities of students.

Checks should be made to ensure that every student in a given class is not writing the same essay under teacher direction. And spot-checks can be made of student writing abilities by outside proctors to ensure that the essays in the portfolios are an accurate reflection of student performance.

STAFFING MATH COURSES AND RETRAINING TEACHERS FOR MATH.

Many of the most effective schools in the County have departmentalized math education, i.e., have specialized teachers, particularly in grades four and five. West Lab has departmentalized math for all grade levels.

Departmentalization appears to be the most successful method for teaching elementary math. Teachers who have been trained in math and math education can do a better job than generalists who know little about math and who often fear it and communicate their fear to students. Specialists are better able to use a hands-on approach and to work with manipulatives. They know what is available for math instruction and use it.

Given the high turnover of teachers, if we began to hire math specialists today, within five years half of the elementary children could be taught by specialists. It would make sense to start with the intermediate grades and work downward. If citizens of the United States are not available as elementary math/science/computer specialists, perhaps we could hire teachers in Latin America with a good command of the English language and the requisite training. This would have the additional advantage of increasing the number of Hispanic teachers.

RECOMMENDATION 7: Specialists in math, science and computers should be hired for elementary schools. Existing teachers should be encouraged to take further courses in math, science, and computers in order to qualify as specialists.

RECOMMENDATION 8: Cross-grouping should be used widely. This means that two teachers in nearby classrooms should divide their responsibilities so that one teaches math and science and the other teaches language and social studies to

each of two classes. In this manner, students will be taught by specialist teachers who enjoy and understand math.

RECOMMENDATION 9: Each school should have a Math Resource Teacher who would teach courses, provide inservice education, plan curriculum, coach peers, and coordinate the school math program.

RETRAINING EXISTING STAFF.

Substantial shortcomings exist in today's in-service training opportunities for teachers. The Teacher Education Center (TEC) has been widely criticized for having low standards. People teaching courses for the TEC are told that they have to ensure that most of their students pass, or they will never teach for TEC again. The teachers themselves have substantial control over TEC through their union, and they act to ensure that standards are low in the program. Little work is required in most TEC courses.

Teachers can win recertification through a scattered melange of short-term courses which do not add up to a coherent program and which have little impact on classroom practice. Other states require a much more integrated series of courses for recertification.

Some local graduate programs for teachers are notoriously easy, and remain so in spite of recent changes. The DCPS itself needs to be more active in encouraging high standards and meaningful curricula in graduate programs attended by large numbers of its teachers. This may be difficult when many DCPS administrators are making substantial sums in teaching for such programs.

RECOMMENDATION 10: Every elementary teacher with responsibility for math instruction should take sixty hours of in-service training over the next five years which stresses the use of hands-on approaches to teaching math.

RECOMMENDATION 11: *The DCPS should work with local universities to develop a more rigorous and meaningful program of in-service training in elementary math and computers. A lengthy series of well-integrated courses should be offered. Substantial salary increments should be given to teachers completing this program.*

RECOMMENDATION 12: *State certification requirements for elementary teachers should include more math courses. State recertification requirements should be made more focused and cohesive in terms of the program of courses taken.*

SECTION FOUR: LOW-INCOME, MINORITY SCHOOLS.

The math achievement level of minority elementary students from low-income families is falling absolutely and relatively in Dade County. This can be seen in the countywide statistics reported in an earlier section, as well as in statistics from the Partners in Education (PIE) schools, an SBM/SDM experiment in the Northwestern High School Feeder Pattern. In spite of this pervasive pattern, however, there are individual schools, such as Drew and Liberty City, where Stanford scores are close to the District average, and there are other schools, such as Floral Heights, where the residual scores are gaining strongly. Obviously, it is possible to create conditions for high achievement in Dade's inner-city schools. What is lacking is the will and determination to bring these conditions about in all inner-city schools in the District.

Although school officials often maintain that these low scores come about because of deficiencies in the family backgrounds of the students, the truth of the matter is that the schools themselves help to bring about these low scores. If this were not true, there would not be such wide differences from school to school. Some have energetic and effective principals and teachers who set high expectations for the students and who provide a warm, caring school environment. Others have staffs which are preponderantly cold, uncaring and ineffective, and where student learning is minimal.

The "time on task" in low-income, minority schools in Dade County is generally very low. One veteran African-American administrator told us that when [s]he visits schools, [s]he notes

TABLE 7: STANFORD MATH SCORES AND RESIDUALS IN THE PIE SCHOOLS.

SCHOOL	S C O R E S			SCORE SHIFTS		
	1987	1988	1989	87-88	88-89	87-89
DREW						
COMPUTATION	48	49	48	1	-1	0
APPLICATIONS	46	39	44	-7	5	-2
NUMBER CONCEPTS	51	50	47	-1	-3	-4
EARLINGTON HEIGHTS						
COMPUTATION	40	42	40	2	-2	0
APPLICATIONS	32	35	32	3	-3	0
NUMBER CONCEPTS	41	41	43	0	2	2
FLORAL HEIGHTS						
COMPUTATION	35	39	44	4	5	9
APPLICATIONS	29	29	32	0	3	3
NUMBER CONCEPTS	34	35	34	1	-1	0
HOLMES						
COMPUTATION	37	41	40	4	-1	3
APPLICATIONS	26	27	27	1	0	1
NUMBER CONCEPTS	32	34	32	2	-2	0
MARTIN LUTHER KING, JR.						
COMPUTATION	42	44	26	2	-18	-16
APPLICATIONS	35	39	22	4	-17	-13
NUMBER CONCEPTS	45	49	31	4	-18	-14
LIBERTY CITY						
COMPUTATION	48	54	47	6	-7	-1
APPLICATIONS	38	42	41	4	-1	3
NUMBER CONCEPTS	41	51	43	10	-8	2
MELROSE						
COMPUTATION	40	44	35	4	-9	-5
APPLICATIONS	28	27	23	-1	-4	-5
NUMBER CONCEPTS	45	29	32	-16	3	-13
OLINDA						
COMPUTATION	33	34	41	1	7	8
APPLICATIONS	31	35	35	4	0	4
NUMBER CONCEPTS	34	32	46	-2	14	12
ORCHARD VILLA						
COMPUTATION	44	39	34	-5	-5	-10
APPLICATIONS	41	35	32	-6	-3	-9
NUMBER CONCEPTS	54	40	34	-14	-6	-20
PIE SCHOOLS AVERAGE						
COMPUTATION	41	43	39	2	-4	-2
APPLICATIONS	34	34	32	0	-2	-2
NUMBER CONCEPTS	42	40	38	-2	-2	-4

	RESIDUALS			RESIDUAL SHIFTS		
	1987	1988	1989	87-88	88-89	87-89
DREW						
COMPUTATION	0.3	4.2	4.7	3.9	0.5	4.4
APPLICATIONS	3.6	-1.2	9.8	-4.8	11.0	6.2
EARLINGTON HEIGHTS						
COMPUTATION	0.6	5.9	-1.1	5.3	-6.0	-0.7
APPLICATIONS	-6.2	-6.5	-5.5	-0.3	1.0	0.7
FLORAL HEIGHTS						
COMPUTATION	-7.1	2.2	0.9	9.3	-1.3	8.0
APPLICATIONS	-5.8	-6.5	0.2	-0.7	6.7	6.0
HOLMES						
COMPUTATION	-3.1	1.3	-1.3	4.4	-2.6	1.8
APPLICATIONS	-2.9	-0.9	-1.6	2.0	-0.7	1.3
MARTIN LUTHER KING, JR.						
COMPUTATION	2.0	-1.1	-18.3	-3.1	-17.2	-20.3
APPLICATIONS	-2.3	-6.3	-17.2	-4.0	-10.9	-14.9
LIBERTY CITY						
COMPUTATION	-0.7	6.4	2.9	7.1	-3.5	3.6
APPLICATIONS	-1.4	6.1	0.0	7.5	-6.1	1.4
MELROSE						
COMPUTATION	-0.9	-6.3	-8.2	-5.4	-1.9	-7.3
APPLICATIONS	-3.9	-4.5	-7.9	-0.6	-3.4	-3.4
OLINDA						
COMPUTATION	-1.8	-7.4	3.6	-5.6	11.0	5.4
APPLICATIONS	-3.6	-1.0	-1.6	2.6	-0.6	2.0
ORCHARD VILLA						
COMPUTATION	5.6	-8.1	-6.6	-13.7	1.5	-12.2
APPLICATIONS	6.1	-2.0	-3.5	-8.1	-1.5	-9.6
PIE SCHOOLS' AVERAGE						
COMPUTATION	-0.6	-0.3	-2.6	0.3	-2.2	-1.9
APPLICATIONS	-1.8	-2.5	-3.0	-0.7	-0.5	-1.1

SOURCE: DCPS, District and School Profiles, 1987-88, 1988-89, 1989-90.

TABLE 8: P.I.E. SCHOOL DEMOGRAPHICS

	PERCENT BLACK STUDENTS	% LOW INCOME	STUDENT MOBILITY
DREW	94	71	35
EARLINGTON HEIGHTS	68	90	52
FLORAL HEIGHTS	99	95	52
HOLMES	100	94	47
KING	99	92	43
LIBERTY CITY	99	86	47
MELROSE	45	88	59
OLINDA	95	82	41
ORCHARD VILLA	98	86	47
AVERAGE	88	87	47

SOURCE: DCPS, District and School Profiles, 1989-90.

in the inner-city schools that the teacher is teaching the class only about one-third of the time. The other two-thirds of the time the teacher is sitting at her desk, doing her nails, writing lesson plans, and doing other work, while the students are doing unsupervised seatwork, such as coloring and filling in ditto sheets. In suburban schools, [s]he notes that the teachers are teaching the class about 80% of the time. The teacher is actively engaged with either the whole class or with a group for most of the time. This, of course, means that the children who need the most teaching get the least. They receive less than half as much teaching as the suburban students. Over the K-12 period, they receive six full years less direct teaching than the suburban students.

This problem is compounded for low-ability inner city students who are in homogeneous groups, whether within a larger heterogeneous classroom, as is typical of elementary school, or in an entirely homogeneous class, as is typical of middle and high school. Teachers spend much less time in direct instruction with low-ability students than with high-ability students. Over six years of elementary school, low-ability students receive two full years less of instruction than high-ability students. Low-ability students cut and paste, while high-ability students read and write. [Canady.] If we put this together with the differences already noted between inner-city schools and suburban schools, this means that low-ability, low-income, minority students receive a pathetically small amount of direct instruction during their time in school.

The problems in the ineffective low-income, minority schools are compounded of the following elements: a series of weak principals who have allowed ineffective teachers to form a dominant clique within the school; area/regional officials who have used the school as a dumping ground for teachers who get into trouble elsewhere; administrators at other schools who play the game they call "pass the trash", i.e., transferring ineffective

putation and math applications for every school with over 75% students on reduced and free lunch which was able to give us the information. There are certainly too few schools in the sample to draw valid conclusions regarding the best curriculum series. One would have to look at much broader samples, perhaps on a national basis, before reliable information was available. However, the most widely used series locally in low-income schools, Harcourt, Brace, Jovanovich's **Mathematics Today**, is associated with the most positive residuals.

According to several schools, next year they will choose a new math series and they intend to choose a management system from the publisher of the textbooks, rather than using TMP as a management system alongside a text by another publisher. Several schools with positive residuals, including Morningside and Citrus Grove, are already using the same management system as texts. This would tend to indicate that consistency between text and management system is a virtue.

Obviously, the math curriculum series is not the whole answer to improving test scores. Wide variations exist among schools using each curriculum. The Riverside series has been chosen in the Edison Feeder Pattern for the students with higher stanines, while other series are used with students at lower stanine levels. Administrators commented that they believed that the Riverside series might be better for students from higher income families in that it was a more difficult series. They considered HBJ's series to be easier and more fully explained. They also praised its management system, which includes an inventory system, pre- and post-tests, workbooks, charts and computer programs.

TABLE 9: MATH CURRICULUM SERIES AND COMBINED MATH RESIDUALS: SCHOOLS WITH 75% OR MORE REDUCED AND FREE LUNCH STUDENTS.

SCHOOL:	COMBINED RESIDUALS	CURRICULUM SERIES
ALLAPATTAH	-17	HM
ARCOLA LAKE	0	HM
BLANTON	-2	HM
BRIGHT	-9	HBJ
BROADMOOR	-24	TMP
BUENA VISTA	-38	HM
CITRUS GROVE	6	RIVERSIDE
COMSTOCK	-14	RIVERSIDE
CROWDER	-11	HBJ
DOUGLASS	-21	HBJ
DUNBAR	-10	RIVERSIDE
EARLINGTON HTS	-7	HBJ
EDISON PARK	-4	HBJ
EVANS	-26	HM
FLORAL HEIGHTS	1	HBJ
FLORIDA CITY	-12	HBJ
HOLMES	-3	HBJ
MARTIN L. KING	-35	HBJ
KINLOCH PARK	-9	HBJ
LEWIS	-24	HBJ
LIBERTY CITY	3	HBJ
LITTLE RIVER	-26	HM
MELROSE	-16	HBJ
MIAMI PARK	-7	HBJ
MIRAMAR	-21	TMP
MORNINGSIDE	6	HBJ
NORTH TWIN LAKES	-7	HBJ
OLINDA	2	HM
OPA LOCKA	-7	HM
ORCHARD VILLA	-11	RIVERSIDE
PHARR	1	HBJ
PINE VILLA	0	RIVERSIDE
SANTA CLARA	-4	HM
SHADOWLAWN	5	HBJ
SHENANDOAH	-14	HBJ
SOUTH HIALEAH	-12	HBJ
SOUTHSIDE	-6	HBJ
TUCKER	-2	HBJ
WEST HOMESTEAD	-1	HBJ
W. LITTLE RIVER	-18	RIVERSIDE
WHEATLEY	-26	RIVERSIDE

TEXT:	AVERAGE RESIDUALS	NUMBER OF SCHOOLS
HBJ	-8	23
HM	-13	9
RIVERSIDE	-10	7
TMP	-22	2

SOURCES: Residuals: Combination of Math Computation and Math Applications residuals on the Stanford Achievement Test, reported in the **District and School Profiles, 1989-90**; Math Curriculum Series: telephone interview with school administrator. HM = Houghton Miflin; HBJ = Harcourt, Brace, Jovanovich; TMP = DCPS's Total Mathematics Program.

Given the special problems faced by many low-income, minority students due to poverty, having a first language or dialect other than Standard American English, recent immigrant status, coming from a single-parent family, and the like, schools need to find appropriate teaching methods to meet the needs of these students. What works in a high-income, Anglo school might not be appropriate.

This is as true with mathematics instruction as with reading and writing. Many math difficulties of low-income, minority students are problems of language. Their terminology for a mathematical concept is different from the Standard American English terminology. A systematic effort must be made by the teacher to translate into Standard American English the mathematical understanding which already exists in the student's mind in his or her own language or dialect—whether Spanish, Haitian Creole, or Black American English. Failure to undertake this translation process will simply result in continued misunderstanding of the math involved. Teachers should be alerted to the most common linguistic misunderstandings and how to overcome them.

RECOMMENDATION 12: The growing research literature on linguistic problems of minorities in understanding math terms and concepts should be assimilated into the teaching practice of DCPS elementary math teachers.

While hands-on math activities and work with manipulatives are recommended for all students, they are particularly important for low-income, minority students, but these are precisely the students least likely to be taught in this fashion. Students who grow up in homes without books and without a lot of conversation with their parents are not likely to relate well to abstractions and symbols in school. They have grown up in a largely concrete world and they respond best to concrete examples in school.

These students are the least inclined to see school as a pleasant place which welcomes them. They are the most likely to be bored and alienated by passive, arid, abstract "skill and drill" approaches. However, if presented with hands-on activities and manipulatives, they are quite willing to participate actively in the learning process.

MULTICULTURAL MATH ACTIVITIES.

Dade needs to bring itself current with the national trend toward providing multicultural math materials and activities. Math should not be presented as a "white thing". One local school is teaching the children to count in Swahili, the main language of East Africa. The rich math background of diverse human cultures should be made apparent to the students, whether through counting games from Africa, Mayan number systems, or Native American geometric designs. Much material is now available to do this, in the form of wall posters, books and teaching materials, and games.

Our schools should reject math materials which only show stereotyped anglo pictures and names. The basic math texts should show cultural sensitivity. [Antonouris; Dyson; Gilbert; ILEA; NCTM, Multicultural; Zaslavsky.]

RECOMMENDATION 13: Math instruction in Dade County should be multicultural. Students should be taught that their own culture has an important mathematically-oriented tradition. And they should be taught to understand and respect the mathematically-oriented traditions of other cultures, particularly those heavily represented in Dade County.

STUDENT VOLUNTEERS.

College students in Dade County are increasingly volunteering for community service activities. The DCPS and the local colleges—through the Miami Compact—should put together a comprehensive plan to get college students into low-income, minority schools as volunteer teacher aides. Several thousand students would probably become involved if this program was well-organized and properly publicized. A special effort could be made to get majors in math, computer science, natural science, and engineering involved in order to help with the objectives set forth in this paper.

Such volunteer work would be valuable for college students in several respects:

—Their desire to be of service to their community would be fulfilled.

—This would be an important item on their resumes in seeking employment or admittance to graduate or professional school.

—Students with an interest in becoming teachers could determine early in their college careers if they really had a calling for this profession.

RECOMMENDATION 14: College student volunteers should be recruited to help tutor low-income, minority students. Special efforts should be made to recruit students with majors in math, computer science, natural science and engineering.

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—Pedro P. Garcia, a senior majoring in Spanish and French.

—Carlos Gonzalez-Buxton, a senior majoring in Physics and Mechanical Engineering.

—Lindy Pickard, a special student majoring in Physical Education.

—Jodi Strauss, a senior majoring in Psychology.

—Petra Toben, a junior majoring in Mechanical Engineering.

—Michael Whelan, Jr., a junior majoring in Civil Engineering.

Research and writing were carried out by Brian Peterson, Associate Professor of History. This is his sixth policy analysis paper on the Dade County Public Schools. He is currently the Director of a Community Summit Conference, "Building Effective Schools". This conference is modeled on state and national summits and will take place in January, 1991.

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After the first draft of our paper was complete, we learned of the DCPS/UTD Joint Task Force on the Improvement of Mathematics Achievement and the Teaching of Mathematics and its report. This document moves in the same direction in which we were moving, but in several areas it had recommendations

which we had not thought of which we immediately recognized as very constructive ideas. These we have now incorporated into our own report, noting the original authorship of the Joint Task Force in each case. We greatly appreciate the efforts of the Joint Task Force and hope that their recommendations are implemented.

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